

Original Research Article

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Evaluation of Water Productivity in Integrated Farming System in Wetland Situation of Western Zone of Tamil Nadu

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ABSTRACT

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Integrated Farming System (IFS) for wetland situation experiments were conducted in Southern block of Agricultural Research Station, Bhavanisagar during 2013 to 2017 under All India Co-ordinated Project on Irrigation Water Management. The objective of the experiment was to work out the water requirements for cropping and livestock components in IFS under wetland situation. In Conventional farming system (CFS), Rice - Rice – Pulse cropping system was followed in one-hectare area. In wetland IFS, Rice - Rice – Pulses (8000 m²), Cumbu Napier grass (1500 m²), Fish pond (300 m²) and others (200 m²) [Dairy unit (2 cows), Poultry unit (30 desi birds), Pigeon unit (10 pairs), Duck (30 birds)]. In IFS, rice crop was cultivated in System of Rice Intensification (SRI) method. Rice (IW Ponni), Pulse (Greengram - CO6) and Cumbu Napier grass (CO(CN)4) were used for experiment. The wetland IFS recorded lower water consumed (20454 m³) compared to CFS (29620 m³). The higher gross income of Rs.527825/-, physical water productivity (3.68 kgm⁻³) and economic water productivity (25.80 Rs.m⁻³) recorded under IFS compared to CFS. It was concluded that the IFS not only influenced the yield but also higher irrigation water productivity. Moreover, benefit-cost ratios with different discount rates indicated that IFS in wetland situation is economically significant.

Introduction

Small and marginal farmers are the core of the Indian rural economy constituting 85% of the total farming community but possessing only 44% of the total operational land (GoI

2014). The average size of operational land holdings has reduced by half from 2.28 ha in 1990-91 to 1.16 ha in 2015-16. The operational farm holding in India is still declining. The declining trend of per capita land availability poses a serious challenge to

the sustainability and profitability of farming (Siddeswaran *et al.*, 2012). Due to ever increasing population and shrinking land resources in the country, practically there is hardly any scope for horizontal expansion of land for food production. Only vertical expansion is possible by integrating appropriate farming components that require lesser space and time to ensure reasonable periodic income to farm families (Gill *et al.*, 2009). The rationale behind integrated farming is to minimize wastes from the various subsystems on the farm. Wastes or by-products from each subsystem are used as inputs to other subsystems to improve the productivity and lower the cost of production of the outputs of the various subsystems (Edwards *et al.*, 1988, Gill *et al.*, 2009). IFS seem to be the possible solution with the changing agrarian scenario of India.

Overall an integrated farming system fulfil the multiple objectives of making farmers self-sufficient by ensuring the family members a balance diet, improving the standard of living through maximizing the total net returns and provide more employment, minimizing the risk and uncertainties and keeping harmony with environment (Mali *et al.*, 2014). Simultaneous production of fish in ponds, with pigs, duck or chicken rearing in pens, beside or over the ponds constitutes a continuous organic fertilization of the pond by the livestock. This practice increases the efficiency and rentability of both livestock farming and fish culture through the profitable utilization of animal and feed wastes (Vincke, 1988; Gill *et al.*, 2005).

The field experiments were conducted at Agricultural Research Station, Bhavanisagar under AICRP- Irrigation Water Management project resulted evaluation of Integrated farming system compared to conventional method of farming in wetland situation.

Materials and Methods

The IFS for wetland situation experiments were conducted in Southern block of Agricultural Research Station, Bhavanisagar during 2013 to 2017 under All India Co-ordinated Project on Irrigation Water Management. The objective of the experiment were to work out the water requirements for cropping components and livestock components in Integrated Farming System under wetland situation, to assess the multiple use of water by way of estimating water use and water productivity in different components of farming system under wetland situations in western zone of Tamil Nadu. For conventional method Rice - Rice – Pulse were followed in one hectare area. In wetland Integrated Farming Systems, the experiment consisted of one hectare area including the components such as Rice - Rice – Pulses (8000 m²), Cumbu napier grass (1500 m²), Fish pond (300 m²) and others (200 m²) [Dairy unit (2 cows), Poultry unit (30 desi birds), Pigeon unit (10 pairs), Duck (30 birds)]. Since it is a farming system experiment it does not involve any specific design and non replicated. Vaccination was done for the poultry birds regularly for Ranikhet disease. Vaccine for Foot and Mouth disease were given for the milch cows once in 6 months.

In integrated farming system, for rice crop, System of Rice Intensification (SRI) method adopted. In which irrigation to a maximum depth of 2.5 cm after development of hairline cracks in the soil. For pulse crop irrigation given based on IW/CPE ratio. For Cumbu Napier grass, surface irrigation given once in ten days. In conventional method of rice cm depth of irrigation adopted. The major soil type of the study area was sandy loam in nature and the soil fertility status was medium in available nitrogen, phosphorus and potash. Two methods of cultivation viz., Integrated

farming system and conventional method were compared by using the varieties for rice (IW Ponni), Pulse (Greengram - CO6) and Cumbu Napier grass (CO(CN)4). The total water use was calculated by adding irrigation water applied and effective rainfall. Yield was recorded and total water used, water use efficiency (WUE) and economics were worked out and presented.

Results and Discussion

In integrated crop livestock farming system, crop residues can be used for animal feed, while manure from livestock can enhance agricultural productivity by intensifying nutrients that improve soil fertility as well as reducing the use of chemical fertilizers (Gupta *et al.*, 2012). Integration of crop

sequences with animal component improved the system profitability in totality even on small farm of 0.50 ha having 32% slope (converted into terraces) at Umiam, Meghalaya, which contributed more than 55% of the total farm income and made the system more remunerative (Panwar, 2014). The inclusion of animal component in the system set a positive link on sustainability by generating cash income, improving family nutrition and recycling crop residues and livestock refuse into valuable nutrient source for crops (Saxena *et al.*, 2003). Integration of livestock with crops on watershed and individual holding basis has been reported to improve the traditional farming system on sustainable and eco-friendly basis (Dhiman *et al.*, 2003) (Table 1).

Table.1 Comparison of water productivity and Economics of Wetland IFS and CFS (Average data)

Enterprises	Area (ha)	Water usage (m ³)	Unit Yield (kg)	Gross Income (Rs.)	Physical WP(kg m ⁻³)	Economic WP(Rs.m ⁻³)
Integrated Farming System (IFS)						
Rice	0.8	7008	5540	71560	0.79	10.23
Rice		7176	5060	75900	0.71	10.58
Pulse		3192	685	54800	0.22	17.27
CO4(CN) grass	0.15	2610	46179	69268	17.69	26.53
Dairy	2 Nos	99.34*	5006 lit	175210	50.40	1764.13
Fish pond	0.03	360**	319	31850	0.88	88.47
Poultry	30 Nos	0.91	84	16700	92.07	18413.07
Pigeon unit	20 Nos	0.37	15	3000	40.89	4256.48
Duck	30 Nos	6.95	348	29538	50.08	8177.36
Total (1 ha)		20454	63234	527825	3.09	25.80
Conventional Farming System (CFS) – Rice – Rice – Pulse (1 ha)						
Rice	1	11795	5317	77123	0.45	6.56
Rice	1	12835	5439	81585	0.43	6.41
Pulse	1	4990	778	62200	0.16	12.56
Total (1 ha)		29620	11533	220908	1.04	7.47

In wetland situation, each one hectare area was allocated for Conventional Farming System (CFS) and Integrated Farming System

(IFS). The total water consumed in one hectare IFS was lower (20454 m³) compared to conventional farming system (29620 m³).

The higher gross income of Rs. 527825 recorded under IFS compared to CFS (Rs.220908). In wetland, the higher physical water productivity (3.09 kgm^{-3}) and economic water productivity (25.80 Rs.m^{-3}) were recorded. This might be due to efficient utilisation of resources (land and water).

Balusamy *et al.*, (2003) explained that the gross income obtained in rice + *Azolla* + fish was 25.7% more over the rice crop and 6.9% more over the rice + fish. The net income followed the same trend. Thus rice + *Azolla* + fish on an average gave 8817/ha more over the rice monoculture and 3219/ha over the rice + fish. This model was proposed for extensive scale adoption in Tamil Nadu. A net profit of about 200% of the total cost indicates the economic viability of the technology. It has considerable potential to provide food security, nutritional benefits, employment generation and providing additional income to resource poor small farmers.

With rice-based IFS in Kerala, major returns by 79% from coconut-banana intercropping in the dykes and field bunds (Mathew and Varughese 2007). Duck droppings also resulted in enhanced profit percentage by 20.5 with net income of 27800/ha. The above amendments have also enhanced the physical properties of soil like bulk density, porosity, aggregates, infiltration rate etc. Channabasavanna *et al.*, (2002) observed from integrated farming system studies at Sirupura that rice-fish-poultry combinations gave highest net income ($> 157000/\text{ha}$) with an improvement in soil health. Kumar *et al.*, (2012) studied different IFS models at Patna and identified crop + fish + duck + goat as the best integrated farming system in terms of productivity and employment generation (752 man-days/year) due to better involvement of farm family labours throughout the year.

In conclusion the results of water productivity in integrated farming system in western zone of Tamil Nadu revealed that the wetland IFS recorded lower water consumed (20454 m^3) compared to conventional farming system (29620 m^3). The higher gross income of Rs.527825/-, physical water productivity (3.68 kgm^{-3}) and economic water productivity (25.80 Rs.m^{-3}) recorded under IFS compared to CFS. It is concluded from the study that Integrated Farming system favourably influenced the yield which resulted in higher irrigation water productivity against lower amounts of water applied. Moreover, benefit-cost ratios with different discount rates indicated that Integrated Farming system in wetland situation is economically significant.

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